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The Grand Design

In the grand design of nature nothing is wasted. The raw materials of earth, water, and atmosphere—fixed in amount at the creation of our planet—are recycled and reused so that new life springs eternally from old. The cyclic economy of nature is a model for the economy of man. Indeed, from early agrarian times the good farmers of many lands have noted the beneficial effects of returning manure and crop residues to the soil. But modern man with his advanced technologies has temporarily disrupted the natural cycle of life. Now less conscious of returning "wastes" to the land from which he gleaned them, he too often dumps them into watercourses, oceans, landfills, burns them, or simply allows them to pile up.

Despite society's concern about environmental problems, we have only begun to exploit the tremendous capacity of our soils to degrade wastes. For the soil is a kind of massive machinery for keeping the chemical stuff of the planet in circulation. Its framework is a collection of individual soil particles, each tiny particle possessing a remarkably large surface. An ounce of soil may have surfaces totaling 250,000 square feet, about 6 acres. The spaces between the soil grains harbor an almost incalculable population of microbial life. A teaspoonful of soil from temperate regions teems with some 5 billion bacteria, 20 million actinomycetes, 1 million protozoa, and 200,000 algae and fungi. The Lilliputian assemblage of just 1 acre of soil carries on life so vigorously that it expends energy equal to that of 10,000 people if they lived and worked there.

Agriculture's long experience in harnessing the soil's microbial life to recycle farm wastes has in recent years also benefited the food-processing industry. Now agricultural science is seeking ways to adapt this approach to handling the organic wastes of urban America: municipal garbage, sewage sludge, and liquid sewage effluent. Urban wastes, however, contain many materials not normally found in soils—particularly heavy metals. To degrade urban wastes, it is vital that scientists develop management and monitoring practices which leave the health and fertility of the soil unimpaired.

Industrial nations have short-sightedly overtaxed the resiliency of water and air to serve as cheap sinks for pollutants. In seeking to reverse the process, research on the soil's inherent ability to biologically break down wastes and return them to the natural cycle of life deserves widespread support.

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COVER: This laboratory mouse may not understand statistical analysis but he does know what he likes—in this case, ammoniated corn (0172X1409–5). See story on page 7.

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Entomologist Robert E. Redfern applies one-tenth of a billionth of a gram of JH–25 to the abdominal end of a yellow mealworm pupa in research aimed at creating monster insects (0273A122–13).

Juvenile hormone makes monster insects

A new superactive hormone mimic called JH–25 zaps yellow mealworms with 100 times greater potency than did earlier compounds. JH–25 could also protect stored food products from another widespread pest—the confused flour beetle.

When yellow mealworm pupae are treated with JH–25 they develop into monsters. They cannot fly, crawl, eat, or reproduce, because only part of their mature characteristics develop. Although JH–25 does not produce bizarre changes in the growth of confused flour beetles, its results are equally fatal to these pests. When treated in the larval stage, few beetles mature. The survivors lay eggs that fail to hatch.

Although more research is needed before JH–25 is ready for use, scientists view it as a valuable contribution to the development of weapons that will be used to control insects in the future. Experimental procedures used in synthesizing JH–25 indicate that the compound would be inexpensive to produce.

Left: *Raised wings on this hormone-affected adult mealworm reveal urogomphi. Unlike some mealworms, this specimen did not retain its gintraps (0273A121–25).*

Above: *Fraction of the new hormone mimic, JH–25, is discussed by the developers, Dr. Beroza (left), Mr. Sarmiento, and Dr. McGovern (0273A123–17).* ***Lower right:*** *Normal pupa of the yellow mealworm on the left and a normal adult flank a JH–25 affected "monster" adult. In this example of arrested maturity both gintraps—the saw-toothed projections on the abdomen and urogomphi—spiked appendages at the tip of the abdomen normally found only on pupae, have been retained (0273A120–20).*

JH–25 is one of a group of new hormone mimics developed at Beltsville, Md., by chemists Rafael Sarmiento, Terrence P. McGovern, and Morton Beroza. Its chemical name is 7-ethoxy-1 - (*p*-ethylphenoxy) - 3,7-dimethyl-2-octene.

Entomolgist Robert E. Redfern and technician Giles D. Mills, Jr., tested JH–25 on several species of insects representing three of the most destructive groups: beetles, moths, and bugs. Of these insects, JH–25 affected only two species of darkling beetles, the yellow mealworm and confused flour beetle. This evidence of selectivity, or effectiveness for certain species of beetles, suggests that JH–25 might be employed without harming pollinating insects, such as butterflies, and other beneficial species, such as the aphid lion.

Scientists have not yet found exactly why juvenile hormone mimics affect some insect species but not others. Some species may possess enzymes or other mechanisms which enable them to inactivate certain hormones. This protective mechanism evidently does not act against JH–25 in immature stages of the yellow mealworm, and only to a limited degree in the confused flour beetle.

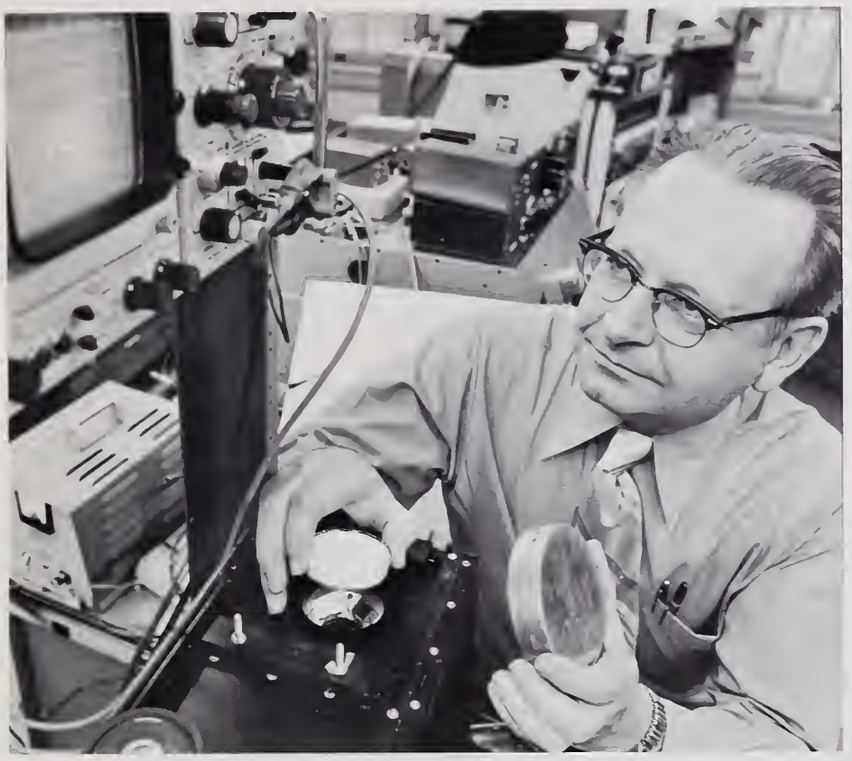
Mr. Redfern disrupted the development of yellow mealworm pupae by applying a mere tenth of a billionth of a gram of JH–25 to the abdominal end of each pupa. A monster then developed; the head and thorax matured into an adult beetle; the abdominal end retained its pupal appearance. The half-pupa, half-adult monster died within a few days without feeding or reproducing. Normal adults usually live 2 or 3 months.

In other tests, Mr. Redfern applied JH–25 at a rate of 0.1 part per million (ppm) to flour infested with 20 larvae of the confused flour beetle. In a 4-week period, no adults developed. When treated at the rate of 0.05 ppm five adults survived 46 days. Adults normally live 2 years or longer. Moreover, treated insects laid eggs that failed to hatch. In contrast, 13 adults and 75 larvae were found in an untreated control container of flour, which originally contained 20 larvae.

The chemists found in related experiments that JH–25 has two advantages over some hormone mimics tested earlier. Sunlight inactivates some mimics, but the chemists recovered 99 percent of JH–25 after 8-hours exposure to sunlight. Moreover, JH–25 will probably resist the adverse effects of rain, according to other experiments.

Further tests will be conducted to determine the effectiveness of JH–25 against insect pests that attack stored grain, flour, and crops in the field. □

Testing seeds for oil and protein?



In tests with the new grain and oil seed analyzer, Mr. Norris observes oscilliscope signal strength prior to inserting a ground wheat sample. The oscilliscope displays a pattern for each filter used to obtain grading determinations (0373A198–3).

THE VALUE of a sack of corn, wheat, soybeans, or peanuts should depend on how much oil and protein the sack contains. Yet great quantities of these grains and oilseeds change hands every day, with buyers and sellers alike lacking precise information about their most important components.

Traders simply have no method of testing for oil and protein that is quick and reliable enough for commodity inspection and grading. However, experimental models of infrared spectrophotometers produced by two commercial instrument makers may bridge this gap.

These experimental analyzers provide instantaneous grading data on moisture, oil, and protein in oilseeds and grains. They have been tested in Illinois and elsewhere for the past 2 years. The trials showed promising results, but also pointed up problems.

Although designed and built commercially, the new spectrophotometers are based on research done over the past 10 years by researchers of the ARS Agricultural Marketing Research Institute under the direction of agricultural engineer Karl H. Norris. Their goal: A device that would just penetrate an intact seed with infrared rays and tell directly how much water it contained.

Scientists have long known that spectrophotometry works well with liquids. For example, alcohol is tested at a wavelength of the infrared spectrum where water is absorbed, then at another wavelength where water is not absorbed, the difference between the values obtained provides an accurate measure of water in the alcohol.

Scientists found, however, that penetration of an intact solid, such as a soybean, does not produce accurate moisture readings. The only way they can get an accurate reading is to grind the sample to a fine powder. But the results are less accurate than the traditional method of weighing the sample before and after evaporating to dryness, because components other than water—notably oil and protein—have some slight absorption at whatever wavelength is chosen to test the sample. Thus, variations in oil and protein content influence the moisture reading.

To correct for these interfering substances, the scientists began testing many different filters. They found that making multifilter readings not only corrected the moisture data, but also provided actual values for oil and protein.

The commercial spectrophotometers are based on these concepts and are now in experimental use for soybeans. In general, they are effective and reliable. One difficulty is that seeds with more than 15 percent moisture cannot readily be ground to obtain the uniform surface needed for accurate readings. A possible solution is to use dry ice in the grinder to solidify the moisture.

The greatest barrier to adoption of these spectrophotometers for routine inspection and grading is the difficulty in calibrating the instruments. For reliable operation, the analyzers must be calibrated with seed samples representing the full range of variations in each component. For example, if a device is calibrated with soybeans varying in moisture content from 8 to 12 percent, it will not give an accurate reading of samples with less than 8- or more than 12-percent moisture.

ARS and the instrument makers are working to improve these devices. It may be 5 years or more, says Mr. Norris, before infrared analysis finds its way into the marketplace as an accepted method of grading and inspecting oilseeds and grains. When it *is* perfected, however, it should bring a new measure of accuracy to the marketing of these crops—and perhaps to meat and other foods as well. □

A soybean plant is inoculated to produce symptoms of bacterial blight caused by Pseudomonas glyciniea *(0373X201–15).*

Bacteria fight soybean disease

BACTERIA that inhibit activity of other bacteria may provide biological control against one of the most costly and widespread soybean diseases, bacterial blight.

Losses to the disease average 2.2 percent annually. The blight can inflict large dead areas on soybean leaves, causing defoliation, especially in cool and rainy seasons. An early symptom of the disease is small, angular, water-soaked spots. The spots turn yellow and then brown as the tissue dies.

ARS plant pathologist Ronald H. Scherff, in cooperative research with the Missouri Agricultural Experiment Station, Columbia, evaluated a parasitic bacterium, *Bdellovibrio bacteriovorus,* as a control agent against bacterial blight caused by *Pseudomonas glycinea. B. bacteriovorus,* a small, comma-shaped bacterium that attaches to the host bacterium, penetrates the cell wall, and enters the host cell where it multiplies. When the host cell collapses, newly formed *B. bacteriovorus* cells, capable of infecting other bacteria, are released.

Dr. Scherff obtained a strain of the parasitic bacteria from soil around soybean roots. One isolate of the bacteria, applied to soybeans leaves, effectively inhibited lesion development and systemic toxemia, also a symptom of bacterial blight. The systemic symptom is thought to be caused by an exotoxin, a poison produced by the bacterial organism, *P. glycinea.*

Large differences were noted in the ability of various *B. bacteriovorus* isolates to inhibit bacterial blight although no physical differences could be seen using phase microscopy. Dr. Scherff then determined differences in average cell burst sizes among the isolates. Cell burst size is the average number of *B. bacteriovorus* cells produced per infected *P. glycinea* cell under specific conditions. There was a direct correlation between average burst size and ability of the cultures to inhibit development of bacterial blight.

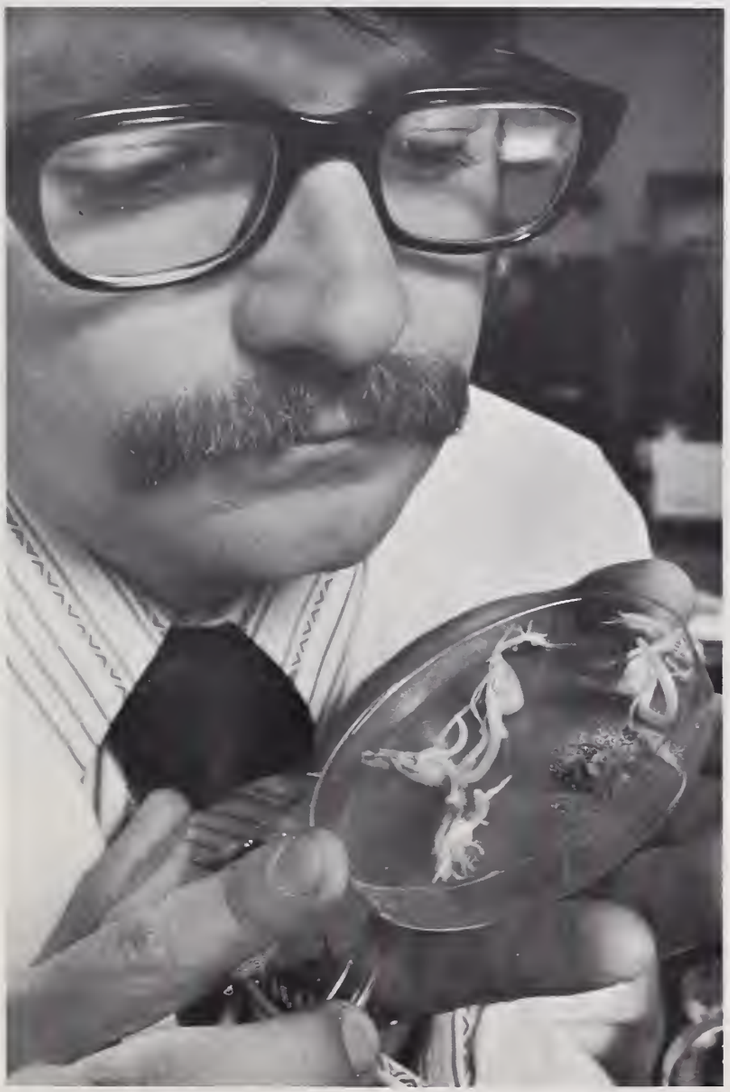
Factors other than burst size may need to be studied before determining whether a particular *B. bacteriovorus* isolate will provide effective control of bacterial blight in practical application.

In other studies Dr. Scherff investigated various concentrations of yellow bacteria, designated as YB–3, for their potential in controlling bacterial blight. The nonpathogenic YB–3 bacteria were isolated from soybeans infected with the blight organisms.

When *P. glycinea* was mixed with YB–3 at a 1:9 ratio and inoculated onto soybean leaves, lesion development of bacterial blight was inhibited. With an application of a 1:4 mixture, symptoms on the soybean plants were about half as severe as on plants treated with *P. glycinea* alone. Applying a 1:1 ratio did not reduce lesion development.

These studies suggest that bacteria similar to *B. bacteriovorus* and YB–3 may have an influence on whether pathogenic bacteria such as *P. glycinea* remain as harmless residents on plants or become pathogens. By manipulating cultural conditions on the plant surface to favor multiplication of nonpathogenic bacteria instead of pathogenic bacteria, plant pathologists may learn how to biologically alter the severity of a particular bacterial disease. □

Ammonia vs. molds in corn



Dr. Bothast observes mold that has occurred on a corn kernel in a mold evaluation test with untreated corn. The corn has been cultured in a nutritious medium of malt extract. The same medium is used to evaluate ammonia-treated corn (1072X1409–4).

ADVANCES in technology in one farming operation often outdate technology in another. Corn producers know this well.

Excessive moisture was not a major problem when corn was picked by the ear and stored in slatted cribs. Picking began after corn was dry enough to crib—usually in cool, fall weather.

Today, technology represented by the picker-sheller has outstripped the older technology of storing and handling corn. Picking now begins while corn is still wet—frequently in hot weather at summer's end.

The moisture content of picker-shelled corn, 20 percent or more, encourages growth of molds and other fungi. They spoil about 250 million bushels of corn every year. They take nutrients from the grain and some can produce toxins. Aflatoxin, for example, is a toxic chemical produced by the mold, *Aspergillus flavus*.

Ammonia can kill these molds. Ammoniation of corn to preserve it for feed and to prevent development of aflatoxin is under study at ARS' Northern regional research laboratory, Peoria, Ill. Also under study is ammoniation to destroy aflatoxin and thus salvage some feeding value from contaminated corn.

Salvaging residual value of contaminated corn by destroying aflatoxin remains distinct, however, from preserving good corn by killing molds.

Rodney J. Bothast, microbiologist, and Earl B. Lancaster, chemical engi-

Below: *In studies to evaluate residual ammonia in known quantities, chemical engineer Earl B. Lancaster exposes treated corn to hydrochloric acid which reacts with ammonia to produce ammonium chloride. The measure of ammonium chloride produced indicates the amount of ammonia remaining (1072X1409–22).*
Right: *In mold evaluation studies, biological aide Gary Adams places ammonia-treated corn on nutritious medium as Dr. Bothast looks on. The plates in foreground contain incubated corn cultured at temperatures favorable to mold growth (1072X1408–6).*

neer, treated corn with two levels of ammonia, 2 percent and 0.5 percent of the corn dry weight. Corn treated at the 2-percent level was soaked to a 26-percent moisture level (wet) before ammoniation. Corn ammoniated at the 0.5-percent level contained 12-percent moisture (dry) when the treatment began.

Ammoniation at either level killed molds and yeasts in wet and dry corn within 2 weeks. Ten percent ammoniation killed these fungi within an hour.

The 0.5 percent treatment killed all fungi except a species of *Fusarium* mold within an hour. Among other molds killed were species of *Penicillium Trichoderma, Rhizopus,* and *Aspergillus,* including *A. flavus.*

Bacteria increased in numbers during corn soaking, but during 3 months' storage 2 percent ammoniation killed all of them. The 0.5-percent treatment did not change the bacterial population.

Statistical analyses of mouse preference for ammoniated corn show inconsistencies by human standards. Mice showed no preference between soaked corn and corn pungent with 2 percent of ammonia, but they ate slightly more

of the unsoaked corn than of that ammoniated at the 0.5-percent level.

Research to develop ammoniation as a way to preserve corn includes studies to find minimum effective levels of ammoniation, ways to prevent air pollution, and feeding tests. Corn preserved with ammonia may offer a feed-value bonus. Ammonia has been tried as a feed nitrogen source for protein conversion by cattle and other ruminants.

Research on ammoniation as a way to destroy aflatoxin in corn has not reached the developmental stage but is continuing at the laboratory level. □

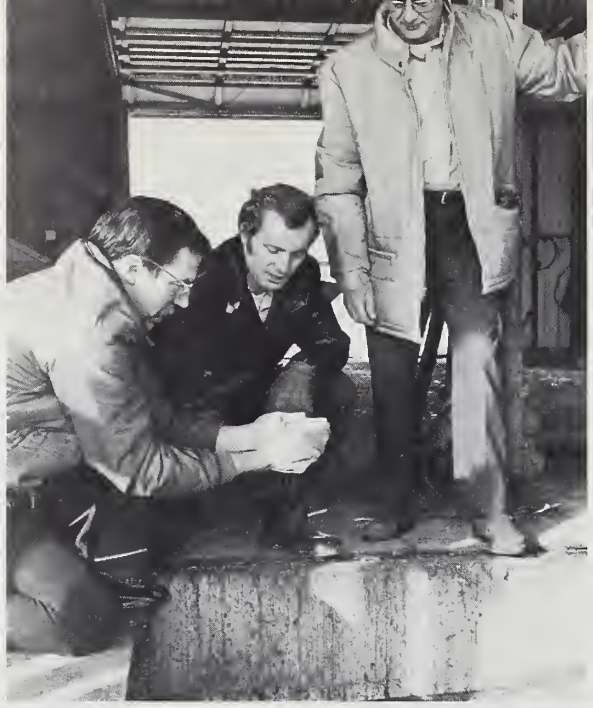
Monitoring molds in Agriculture

The scientific community has been deeply involved in research on mycotoxins since the mysterious deaths, more than a decade ago, of 100,000 turkey poults in England. That episode was traced to aflatoxin, a metabolic product of the fungus *Aspergillus flavus*. Since then, aflatoxin contamination has been found in certain grains, oilseeds, and nuts in the United States.

Molds are widespread in nature, but relatively few are harmful. Even so, over the centuries they have caused massive outbreaks of mycotoxicosis in humans. Perhaps the earliest known of such outbreaks is ergotism which derives from eating moldy rye grain. Epidemics of ergotism have hit Europe since Medieval times, and outbreaks still occur—one in France as recently as 1953. In recent years, toxins from organisms that carry the "yellow-rice disease" have also caused a beriberi-like disease and other toxicoses in Japan.

While mycotoxins have long been with us, only during the past decade, when the acute toxicity and carcinogenicity of aflatoxin became known, was it generally realized that relatively low levels of mycotoxin contamination of foods could present serious health problems. Research shows that aflatoxin is harmful to many mammals, fish, and birds. While there is little direct evidence of aflatoxin harming humans, there are a few documented cases of it affecting children in Thailand, a country that lacks a highly developed technology for processing and handling foods. The fungi that produce aflatoxin are ubiquitous. Accordingly, farmers, industry, scientists, and Government agencies are cooperating to take all steps necessary to insure consumers a safe and wholesome food supply.

With recognition that aflatoxin poses a threat to health, ARS promptly responded with a broad-based research effort. For example, ARS scientists have developed and are improving tests for monitoring agricultural commodities for the presence of aflatoxin. In other research they are devising preventive methods to keep aflatoxin contamination from occurring in the first place through proper cultural practice, harvesting, storing, and handling. They are also improving methods for removing contaminated material from food products, and of detoxifying contaminated commodities to render them safe for feed use. As research progress is achieved, it will periodically be reported in this magazine.



Oxidation ditch

COLLECTION, temporary storage, and partial treatment of feedlot wastes in an oxidation ditch is a promising way to restrict environmental pollution associated with feeding cattle in confinement.

In this system, wastes drop through slatted floors of animal confinement areas into the oxidation ditch, which is partially filled with water. The contents of the ditch are circulated constantly, thus aerating and mixing them to promote bacterial breakdown and restrict odors. The ditch is emptied periodically and the contents spread on cropland.

Agricultural engineer Russell E. Larson, St. Paul, Minn., says the oxidation ditch reduces water pollution by wastes in the feeding area and keeps objectionable odors at a relatively low level. Treatment of waste in the ditch reduces its pollution potential when spread on land but is not sufficient for the waste water to be discharged directly into a waterway or lake.

Mr. Larson and ARS agricultural engineer Richard O. Hegg have cooperated with agricultural engineers James A. Moore and Evan R. Allred of the Minnesota Agricultural Experiment Station, St. Paul, in studies on oxidation ditch design and operation since 1967. Their studies at Rosemount show how the oxidation ditch can successfully be teamed with the new confinement system of feeding livestock—and that it can be operated in regions subject to extended periods of subzero

Upper right: *Mr. Moore, Mr. Hegg, and Mr. Larson (left to right) check foam level in oxidation ditch. Mr. Larson recommends a batch system of operation for control of odors and foaming (0373X180–21).* ***Above:*** *Cattle used in experiment are housed directly over ditch. Waste material enters ditch through slatted floor (0373X180–10).* ***Right:*** *Mr. Moore and Mr. Larson examine undigested corn that is salvaged from bottom of ditch. Salvaged corn can be refed to cattle (0373X179–8).*

reduces feedlot pollution

weather. Although confinement feeding has potential advantages of improved production efficiency through environmental control, that is, protection from stressing weather conditions, and efficient labor use, these advantages can be negated by mismanagement of the concentrated animal wastes.

The oxidation ditch at Rosemount, oblong in shape with a partial lengthwise dividing wall, provides a "racetrack" 170 feet long, 7 feet wide, and 4½ feet deep for circulation of liquid wastes by a rotor. Thirty-six beef steers in animal environmental units set over the ditch received a high-energy ration of 90 percent rolled or whole corn, 7.5 percent ground hay, and 2.5 percent concentrate in the experiments.

Treatment in an oxidation ditch is a biological process in which bacterial activity responsible for breakdown of wastes is generally lowered as temperature is reduced. The Rosemount ditch is operated as a totally enclosed system with exhaust air from the environmental units drawn down through the slats, over the liquid surface, and then discharged by fans at the ends of the ditch. With this system, the liquid temperature did not fall below 35° F. although outside air temperatures dropped into the −20° F. range.

Mr. Larson recommends a batch system of operation for control of odors and foaming. He advises that the ditch be emptied as late in the fall and as early in the spring as possible, as well as one or more times during the summer. In the studies, biological activity reduced solids by 34 percent during a 150-day feeding period, but up to 6 inches of settleable solids accumulated. These solids consisted of treated sludge plus particles of corn. Complete waste treatment would be possible but very expensive because the waste load would preclude using the animal confinement units to capacity.

The ditch has been almost free of obnoxious odors during cold-weather operation and until overloaded in warm weather. The combination of higher temperatures and accumulated solids increases biological activity to a point where the rotor is unable to supply and maintain the dissolved oxygen content necessary for complete aerobic operation. Some activity is then anaerobic, resulting in some undesirable odors.

Leaving some wastes in the ditch at cleanout time controls foaming on the ditch surface at the beginning of the next batch operation when biological activity has not yet reached a steady state. Emptying the ditch one or more times during the summer to keep the solids content below 6 or 7 percent helps to minimize foaming and odors.

Further research is needed to establish the optimum water level in the ditch, develop more efficient rotors or other aeration equipment, modify the ventilation system to prevent fogging in the confinement units, and determine the most efficient method of removing and utilizing solids from the ditch. □

Mr. Hegg and Mr. Larson sample waste material in experimental ditch. These studies show how the oxidation ditch can successfully be teamed with the new confinement system of feeding livestock—and that it can be operated in regions subject to extended periods of subzero weather (0373X180–1).

Screening cotton for bollworm resistance

A TECHNIQUE for screening cotton lines for pink bollworm resistance could lead the way to fighting this pest without the use of chemicals.

The pink bollworm ranks as one of the most destructive cotton pests in the world. It is the major pest in Arizona and the desert valleys of California. Chemicals presently provide the most effective control. The effectiveness of chemical control, however, is somewhat limited because newly hatched larvae bore into the developing bolls and, once inside, these larvae are protected from any further chemical treatment.

Entomologist Richard L. Wilson, Phoenix, Ariz., says the screening technique involves picking bolls from several hundred rather primitive cotton lines being grown in Veracruz, Mexico. These bolls are frozen with dry ice and shipped to the ARS Western Cotton Laboratory, Phoenix.

There, the bolls are broken open and separated into two components, the boll content and the carpel wall—rind. Then, this material is freeze-dried and incorporated into the standard laboratory diet for rearing pink bollworms.

Newly hatched pink bollworm larvae are placed on the test diets, then any effects on larvae development are monitored.

Dr. Wilson, who developed the technique with the aid of research geneticist F. Douglas Wilson, also of Phoenix, said that thus far, six diets have shown some degree of suppression of pink bollworm development. Three of the diets have prevented all larvae from reaching the adult stage.

The next step, Dr. Wilson said, is to cross one of the primitive cotton lines with commercial varieties and then evaluate the resulting bolls for resistance through the diet technique.

"Since this screening technique is based on using modified diets, much additional greenhouse and field testing is necessary to determine whether or not a true form of resistance can be demonstrated in the actual cotton plant," Dr. Wilson said. □

Parasitic wasps follow their noses

ANYONE who has ever spent time looking for a place to stay knows how difficult it can be to find a host. Yet, somehow, a tiny parasitic wasp used in biological insect control programs gets the job done by following its nose.

Trichogramma evanescens, the diminutive wasp in question, attacks crop-devastating insect pests by laying its own eggs in the eggs of a host insect. When its egg hatch, the grubs devour the host eggs. (AGR. RES., Jan. 1970, p. 8).

ARS scientists set out to determine the mechanism which triggers the parasite's searching behavior, as well as possibilities for exploiting this behavior.

Earlier studies with corn earworm moths indicated that parasitism by the wasps was higher for eggs in areas contaminated by moth odor. Scales left by moths while laying eggs seemed to be the source of a stimulant that directed wasps to the host eggs.

The scientists made extracts from these moth scales and tested their effect on the wasps' seeking behavior in the laboratory, greenhouse, and in the field. In all cases, moth eggs placed in areas treated with the scale extract suffered about 50 percent more parasitism than untreated eggs.

In later investigations, the scientists looked more deeply into the components of scale extract. They isolated four chemicals, all straight-chain hydrocarbons which increased parasitism by the wasps. They are: docosane (n-C_{22}), tricosane (n-C_{23}), tetracosane (n-C_{24}), and pentacosane (n-C_{25}). Tricosane produced the greatest stimulation and had the greatest effect on orientation of wasps in laboratory and field tests.

The complete role of this chemical mediator between host and parasite is yet to be determined. Studies are now underway to explain that role and develop methods of employing the chemicals to attract and hold parasites in a general area of existing or potential infestation, and to increase the intensity of the wasps' searching behavior.

Studies were conducted by ARS entomologists W. Joe Lewis, Richard L. Jones, and Alton N. Sparks, Southern Grain Insects Research Laboratory, Tifton, Ga., and chemists Morton Beroza and Barbara A. Bierl, Agricultural Environmental Quality Institute, Beltsville, Md. □

Breeding resistance in rice

During the sixties rice geneticists concentrated on breeding for high yield, and they succeeded—creating varieties that paralleled the pontential of the high-yielding dwarf wheats. Now, under an ARS-sponsored project, rice geneticists are concentrating on breeding pest and disease resistance into these new varieties.

Indian scientists participating in this work collected over 6,000 cultivars for screening. ARS-cooperating scientist C. Roy Adair, a research agronomist at Beltsville, Md., said this effort stems from recognition that the new high-yield varieties generally have low resistance to major pests and diseases.

"In this new collection," Dr. Adair said, "5,000 cultivars came from a group of States, including Assam, in India's Northeast where, the project scientists reasoned, plant variability accumulated over prolonged periods of natural and human selection, would be preserved." This Indian region is an isolated area settled by different ethnic groups who brought with them diverse plant types and agronomic practices in the prehistoric and historic past.

"The results of screening," Dr. Adair said, "confirmed the Indian assessment. They found in the Assam Rice Collections (ARC) several new sources of natural resistance to stem borers, gall midges, leafhoppers, rice blast disease, bacterial leaf blight, and rice tungro virus. Further, some of the cultivars showed multiple resistance. For example, each of four that are highly resistant to gall midge also exhibit resistance to one other disease or pest."

In addition to resistance characteristics, spin-offs from the Indian research, are findings of high protein and amylose content in some of the promising donor strains. The protein content varied from 6 to 14 percent. Of 300 collections tested, 20 types had a protein content of more than 10 percent. The amylose content varied from 0.0 to 29.5 percent. Of those tested in the United States, one type had a protein content of 12.9 percent, and another had an amylose content of 32 percent. Protein content of U.S. grown rice averages between 7 and 8½ percent; amylose content of 27 percent is considered high.

The United States is the world's leading rice exporter. In fiscal 1972 this country exported 1,644,745 metric tons (BN–40101).

During 1970 and 1971 about 190 cultivars from the ARC were grown under quarantine at Plant Industry Station, Beltsville. In 1972 an additional 275 cultivars were grown under quarantine at Imperial Valley Field Station, El Centro, Calif. As soon as these processed seeds become available, this germ plasm is sent to various ARS and State testing stations including: Beaumont, Tex., for evaluation against rice blast disease and determination of amylose content; Baton Rouge and Crowley, La., for testing resistance against stem borer and rice water weevil; and Davis and Biggs, Calif., for water weevil resistance evaluation. The protein content is determined at Beltsville.

The Indian work was a joint project of the Indian Agricultural Research Institute (IARI) and the All India Coordinated Rice Improvement Project. The principal investigators for the grantee, IARI, New Delhi, are Dr. M. S. Swaminathan and Dr. S. V. S. Shastry. This Public Law 480 grant is part of USDA's contribution to a global endeavor now coordinated by the International Rice Research Institute, the Philippines. □

Alfalfa clones...
Indicators of air pollution

NINE CLONES or cuttings of alfalfa resistant to air pollution and five more that are highly susceptible are being released to scientists for alfalfa improvement and air pollution research programs throughout the country. Their main value seems to be in studies on the mechanism of resistance in plants and as bioindicators of plant stress.

ARS scientists report that about 40 requests for the clones have been filled so far. More requests are anticipated.

Resistance to air pollution can be measured in alfalfa by its degree of tolerance to ozone injury. As far as scientists can tell, ozone is one of the main components in the air-pollution complex that damages the plant. In essence, resistance to ozone is resistance to oxidant air pollution.

The extent of damage to alfalfa from air pollution is not clearly known. Recent reports, however, indicate that annual losses to growers in southern California amount to $10 million.

The resistant and nonresistant materials were developed at the Agricultural Research Center, Beltsville, Md., by Robert K. Howell, plant pathologist of the Center's Air Pollution Laboratory, and Thomas E. Devine and Clarence H. Hanson, plant breeders of the Applied Plant Genetics Laboratory.

This line of investigation began when plant breeders at Beltsville observed that alfalfa strains selected for other characteristics appeared to be more resistant to air pollution damage than strains selected elsewhere. The researchers then subjected plants of three varieties used in the alfalfa improvement program to high levels of ozone. Five of the most tolerant and five of the least tolerant plants of each variety were selected and propagated as clones. Ultimately, nine highly resistant and five highly susceptible clones were picked. All of the resistant clones were isolated from strains that had undergone previous selection at Beltsville.

A pedigree statement was written on the 14 clonal selections and an announcement of their availability was distributed to over 300 people involved in breeding and air pollution studies.

One of those receiving the clones was Dr. O. Clifton Taylor of the Statewide Air Pollution Center, University of California at Riverside. He reported that the resistant plants had considerably less leaf damage and shed fewer leaves than the susceptible ones, and had twice the growth. In all tests, susceptible plants have been especially sensitive to leaf-shedding, which reduces the nutritive value of the crop as a forage.

The tolerant plants are now being further evaluated in the field for resistance to air pollution. They are also being analyzed in the laboratory for their nutritive value and their resistance to leaf diseases and insects.

These clones are available to interested scientists for research purposes and can be obtained by writing to: Dr. C. H. Hanson, Applied Plant Genetics Laboratory, Agricultural Research Center, Beltsville, Md. 20705. □

AGRISEARCH NOTES

A better firming wheel

COTTON GROWERS have known for over 40 years that seed firming wheels attached to their mechanical planters aid in more uniform germination and stands.

Firming wheels follow the bottom of the furrows made by the planter and press the cotton seeds into the soil, thus insuring good contact between the seeds and the soil. However, growers sometimes remove these wheels because they are prone to clogging and often fail to press some seeds. A new wheel, developed by engineer Lyle Carter, of ARS' Cotton Research Station, Shafter, Calif., eliminates these disadvantages.

The new wheel, successfully tested on a 1-acre plot, is made of aluminum and weighs only one-tenth as much as its conventional counterpart. A spring provides 90 percent of the force necessary to press seeds into soil. Wheel response to soil irregularities is about 10 times faster than with a conventional wheel, thereby virtually eliminating wheel bounce at normal operating speeds of 2 to 4 miles per hour (mph). When conventional wheels bounce, they do not press the seeds into the soil properly. The spring is adjustable so that the tension exerted on the wheel can be matched to different soil and moisture conditions.

The seed firming wheel has a flat surface that can be scraped easily to prevent clogging. Mr. Carter says that a Teflon coating or oil film would make the scraping even more efficient.

In addition, the new wheel gives as good a performance up to 6 mph as a conventional wheel gives at 1 mph.

An aesthetic green for noodles

IF conventional spinach egg noodles turned green with envy they still couldn't match the bright green color of spinach egg noodles obtained by following an ARS-recommended formula.

A small-scale frozen egg noodle manufacturer in Iowa sought a means to brighten spinach-colored egg noodles to a color resembling the green in the layer beneath the skin of a ripe avocado. The manufacturer's own recipe produced a gray-green color that faded when the product was frozen.

The noodle manufacturer took the problem to the Iowa Agricultural Extension Service, Ames, who referred it to ARS. Food technologist Catherine Dunlap, Berkeley, Calif., found that most of the change from bright green to gray-green occurred during the cooking of both the frozen spinach and the final noodle product. She attributed this color to chlorophyll conversion and found that raising the dough mixture's alkalinity slightly with trisodium phosphate reduced the conversion.

As a result, the uncooked blanched-frozen spinach was pulverized easily and the manufacturer's cooking step could be eliminated. The dough resulting from this modified ARS-version of the Iowa noodle processor's recipe held its bright color even after the noodles were cooked with no detectable off-flavor. The Iowa Extension specialists report that the manufacturer plans to market the new green noodles soon.

Traps trim insecticide use

AN INDIANA APPLE GROWER needed only half the usual number of insecticide applications for controlling codling moths when he used an experimental technique to time the sprayings.

The technique, under study by ARS entomologist Tim T. Y. Wong, Vincennes, Ind., involves the use of sticky

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traps containing virgin female codling moths to detect insect flight. The traps capture male moths attracted to the females used as bait.

The grower applied eight cover sprays in 1968, when he did not employ the baited traps. The next year, using the sex-lure traps in a precisely timed schedule designed to control a majority of egg-laying females, he needed only five cover sprays, with no loss in fruit quality. The number of sprays was reduced to four the following year without loss of effectiveness.

An added, unpredicted benefit from fewer insecticide applications was an accompanying reduction, from four to two, in the number of miticide applications. Overuse of insecticides in orchards may inadvertently eliminate natural enemies that help hold mite populations in check.

New process for prune juice

PRUNE JUICE produced by a continuous process has a more natural fruit flavor, lacks the caramelized taste of regular prune juices, and takes less time to produce.

This process, developed at ARS' Western regional research laboratory, Berkeley, Calif., by chemists Harold R. Bolin and Allan E. Stafford, takes only about 30 minutes and yields from 450 to 570 gallons of juice for every ton of dried prunes.

A slurry is made out of ground prunes and water, then an enzyme added to break down pectin. Unless pectin is broken down, it will cause the thickening of fruit products during and after processing, preventing easy separation of liquids from the solids. The slurry is heated to 140° F. to speed enzyme action. After 10 minutes the temperature is raised to about 195° F. to inactivate the enzyme.

Pits, skins, and sediment are removed by filtration or centrifugation, or by a combination of the two methods. When filtered, the final product is recovered by adding a filter-aid like that used in making apple juice. This keeps the suspended material in the unfiltered juice from clogging the final filtering process.

The two methods currently being used are time consuming batch processes, which produce about the same amount of prune juice as the new continuous process.

Juice produced by the new process has a mild fruit flavor but lacks the caramelized taste of regular prune juices. A more caramelized prune juice flavor is possible, however, with the continuous process by baking the prunes slightly before processing.

Waste from the new process (pits, skins, and sediment containing significant amounts of vitamin A) may prove of value for livestock feed or soil conditioner. This would eliminate today's disposal problem.

A commercial plant in San Jose, Calif., is designing a new facility for producing this enzyme-processed prune juice.

Correction: Dimethoate

Our December 1972 issue carried an article entitled "Remote Sensing vs. Citrus Pests" which stated that dimethoate is "not toxic to birds, wildlife, or humans." It should have been mentioned, however, that dimethoate is highly toxic to honey bees, and that anyone who applies the pesticide should avoid letting it come in contact with his skin.

When reporting research involving pesticides, this magazine does not imply that pesticide uses discussed have been registered. Registration is necessary before recommendation. Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if not handled or applied properly. Use all pesticides selectively and carefully.

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